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HENRY HORNER, Governor

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LIST OF SPEAKERS

A committee designated by the Council of the Academy has prepared a list of speakers who are willing to present talks on various phases of science before interested groups. Unless otherwise indicated, these speakers are willing to give their services for expenses only. In some cases a small honorarium is expected. A copy of this list of speakers may be obtained gratis by sending a request to:

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NOTICE

The Committee on Research Grants of the Illinois State Academy of Science announces that requests for small grants to aid research will be received up to February 1, 1940. Requests should be accompanied by detailed statements of preceding background, general purpose, and estimated expenses, and supported by three letters of recommendation sent directly by the writers. Grants for individual projects will probably not exceed $75. It is the custom to make grants only to scientists connected with smaller institutions within the State. Correspondence should be directed to C. H. Behre, Jr., Department of Geology and Geography, Northwestern University, Evanston, Illinois.

INTERGLACIAL AND POSTGLACIAL VEGETATION OF ILLINOIS*

GEORGE D. FULLER

University of Chicago, Chicago, Illinois

AS THE OBSERVER explores the forests and the remnants of the grasslands of Illinois he is led to inquire what has been the past history of the vegetation of the State. Neglecting the cycads, the horsetails, the ferns, and their associates that formed the coal measures millions of years ago, and considering the past half-million years only, the picture of the plant cover of the hills and valleys is very incomplete. Such plant remains as have been found are encountered, for the most part, in various peat deposits; many of them deeply buried in glacial drift. During the past 50 or 60 years numerous reports have appeared of the finding of the remains of the interglacial vegetation which were encountered in well drillings, mine shafts, and road and stream cuts. These remains were seldom identified with any desirable degree of scientific accuracy. The wood, for example, was named usually on its external resemblance to that of living trees.

During the past quarter of a century there has been developed, however, a more exact and scientific technique for the examination of plant remains found in peat deposits. It is based on the fact that the exines or outer coats of many pollen grains are very resistant to decay when immersed in pond or bog waters and may be identified with accuracy even after intervals of tens or hundreds of thousands of years.

This technique was first developed in northern Europe about 25 years ago. There a group of Swedish workers led by von Post and Erdtman examined peat deposits microscopically and finding in them well preserved tree pollen elaborated a technique now well known under the designation "pollen analysis." Erdtman has been one of the foremost investigators in this field and has accumulated many valuable data (7). He has made the technique internationally known and has devoted much attention to its improvement (9, 10). Many European investigators have used these methods and there has accumulated a great mass of data indicated by the hundreds of titles listed by Erdtman (8) in his bibliography of the subject. The testimony of many investigators and some statistical observations have led to the acceptance of the data of pollen analysis as being reliable within certain limitations.

It is not our purpose to discuss the details of the technique of pollen analysis, except to say that instruments are available by which samples of peat may be taken from bogs from known depths. These samples are so treated that the extraneous substances are removed and the pollen grains made more recognizable. These grains are examined and counted under a compound microscope. Further details of the process may be found in the contributions of Erdtman (8), Sears (16, 17), Godwin (12), Voss (18, 19, 20, 21) and others. It may be significant, however, to examine some of the limitations to be observed in the interpretation of the results thus obtained.

Both American and European investigators have found the pollen of tree species more useful and better preserved than that of herbaceous plants. Such pollens may be recognized as belonging to the genera of the trees producing them, and as found in peat deposits, may be classified with regard to their source on the basis of distance of transport as:

1. Pollen from trees growing on the bog and its immediate margin;
2. Pollen from trees in the forest within a radius of 1000 yards of the margin of the bog;
3. Pollen from trees between 1000 yards and 5 miles of the bog;
4. Pollen from trees more than 5 miles from the bog.

These pollen components may be termed respectively the bog, regional, distant,

*Address of the retiring President of the Illinois Academy of Science, presented at the Thirty-second Annual Meeting, Springfield, Illinois, May 5, 1939.

and remote components. Von Post, Erdtman, and others have shown that the regional component is the largest and most important of these, with the distant component second in size and importance.

This may explain how pollen analysis gives, as a rule, a general picture of the forest type for a rather wide area, not a representation of the local tree growth on the bog itself and its immediate margin. That is to say, the pollen diagram points to the general character of the forest-cover of the whole countryside and this characteristic adds to its value as an indicator of the regional vegetation of past ages.

Amounts of pollen are expressed in percentages of the total tree pollen. It has been found impossible to express the amount of each pollen on an absolute scale. It is therefore true that the amount of pollen from any one species always affects the percentage values for all other species, hence although the results do not show the absolute abundance of any one tree they do indicate changes in the relative abundance of the pollen of different tree genera.

The pollen diagram must not be interpreted in detail, for the presence of a few scattered grains of any particular species cannot be accepted as proof that the species was growing in the immediate neighborhood of the deposit; they may have been windborne from a great distance. Hence they must be neglected unless the presence of the species in the vicinity is assured by other data. It should also be remembered that some tree genera produce much more pollen than others, that certain pollens are much better preserved in bogs and that certain tree genera, on account of their narrower ecological range, are much better indicators than others.

It is therefore evident that a pollen diagram (or diagrams) of an entirely unknown forest would not accurately reveal the tree population of such a forest. But such diagrams would permit a choice to be made from a score of known forest types—the predominating type, or types, could be distinguished in spite of the fact that not all its tree components were represented in the pollen diagram, thus an abundance of *Abies* and *Picea* pollen in the Great Lakes region would make it most highly probable that *Larix*, *Betula*, and *Fraxinus* were also present in considerable numbers in the region adjacent to the bog, and that the forest was of the northern conifer type.

Presentation of Results

From the nature of the data it is most desirable that generalizations based on pollen analysis should be made only upon very considerable accumulations of evidence. In other words, the data from a single bog, even though carefully collected and accurately analyzed, may be used for a general picture of the surrounding forest only when supported by other data. Such accumulations of data, until very recently, have been lacking in America and are still decidedly deficient. In this field, Voss of Peoria has been the outstanding American investigator, and the only one who has studied the interglacial deposits. To him the writer is indebted for the greater portion of the data on which this article is based. Other workers include Houdek of Illinois, a group of workers connected with Butler University in Indiana, Sears and his associates in the Lake Erie region, and Wilson and Hansen in Wisconsin.

The northern half of Illinois seems to be particularly well suited for such studies of past vegetation. At least four ice sheets have crept down from the North to cover portions of its surface, and retreating have left drift in which were depressions that became occupied by ponds and lakes. These have developed vegetation that decayed into peat bogs. Some of these peat deposits have been buried by the moraines of succeeding ice sheets, compressing the peat, but aiding in preserving its store of tree pollens.

The Pleistocene with its glaciations has been investigated by many geologists and many of their data have been presented in interesting form by Daly (6). Leighton (14, 15) and Ball (2) among others have studied the moraines and other evidences of the ice sheets that have visited Illinois. Various estimates have been made of the duration of the ice sheets and of the interval between them. It seems to be particularly difficult to estimate the length of time required for the accumulation and the subsequent disappearance of these immense glaciers. The following estimates taken from the best authorities available, must be regarded as tentative approximations for the past half-million years. The following stages are recognized:

Fig. 1. Map of the Wisconsin drift sheets. Compiled by Voss.

Recent or postglacial time, 25,000 to 30,000 years
Wisconsin glacial stage, 100,000 years
Sangamon interglacial stage, 120,000 years
Illinoian glacial stage, 100,000 years
Yarmouth interglacial stage, 200,000 to 300,000 years
Kansan glacial stage, 100,000 years.

The most complete picture of the vegetation of the northern half of Illinois for the past 25,000 or 30,000 years comes from a group of seven bogs in Lake County found in Cary (3rd) substage of the Wisconsin drift, and investigated by Voss (19), (fig. 1).

The present vegetation of several of these bogs has been described by Waterman (22, 23) and by Kurz (13). They are found scattered in a rolling morainal area in a county that seems originally to have had at least three-fourths of its surface covered with deciduous forests.

The pollen analyses of these bogs show such remarkable agreement in their pollen diagrams that the results are most convincing. One of these diagrams may be taken as representative of the group (fig. 2). In interpreting these diagrams it must be remembered that the seven bogs, being in the same moraine and necessarily of similar age, differ considerably in depth. This necessitates some adjustments in the vertical length of the graphs when we attempt to synchronize the records.

It may be instructive to make such adjustments and to compare the pollen curves for the same species in the group of bogs.

The balsam fir, *Abies balsamea*, may be regarded as a good indicator species. It is found represented by its pollen in all seven Illinois bogs at the bottom of the deposits. The pollen curves from the seven bogs plotted together show an abundance of the species in the earliest centuries of the bog deposits but also show its disappearance relatively early in the history of the deposits (fig. 3). With our present limitations of knowledge it is impossible to more than approximate the time of the disappearance of *Abies* from the deposits and hence from the forests of Illinois, but if we accept the time of the recession of the last Wisconsin ice sheet as occurring some 25,000 years ago it seems likely that fir entirely disappeared during the first 5,000 or 6,000 years or about the end of the first quarter of that period. Data from the bogs of northern Indiana, collected by Houdek and others, although not yet as abundant as those from Illinois, give similar graphs for *Abies*.

These Illinois and Indiana bogs also show the early presence of spruce in the forests of the region and apparently the genus *Picea* persisted for a slightly longer period than did the fir but it also probably disappeared soon after the close of the first quarter of postglacial time. The curves representing the occurrence of *Picea* in the forests near all seven bogs are very similar (fig. 4).

As an indicator the genus *Quercus* seems to rank with *Abies* and *Picea* as very significant. Oak pollen appears in all the bogs of postglacial age that have been investigated. The pattern of its graphs is strikingly different from those of the fir and spruce but this pattern remains very constant throughout all the Illinois and Indiana bogs. It is found in small quantities at the bottom of the deposits, reaches a maximum about the time that the fir and spruce disappear and persists with irregular fluctuations to the present (fig. 5).

No other tree genera give records, comparable in importance to those of *Abies*, *Picea* and *Quercus*. The *Pinus* record would indicate the presence of the genus throughout practically the entire postglacial period with no decided or regular times of maxima or minima. *Carya*, in the Illinois bogs roughly parallels *Quercus* with much smaller percentages of pollen. *Tilia* and *Acer* show a wide distribution both in time and space, but present narrow and irregular pollen curves that are difficult to interpret.

Comparable to the record of the 7 bogs from the Cary or Late Wisconsin stage is that from 9 bogs of the Tazewell or Early Wisconsin substage (2nd) also studied by Voss (20). They occur in moraines of similar age and are found in Bureau and adjacent counties. The bottom of these deposits was laid down 35,000 or 40,000 years ago or probably 10,000 years earlier than the base of the Cary deposits just discussed. The pollen record is similar to that of the more recent deposits except that the fir and spruce pollens appearing most abundantly at the bottom of the bogs persist for a relatively longer time and the period of the dominance of oak is relatively shorter. Doubtless portions of northeastern Illinois were still covered with Late Wisconsin ice while these peat deposits were being laid down.

Passing from the records connected with the Wisconsin Glaciation and the postglacial interval that has succeeded it we come to the more remote Sangamon Interglacial Stage. The last centuries of this stage were probably some 125,000 or

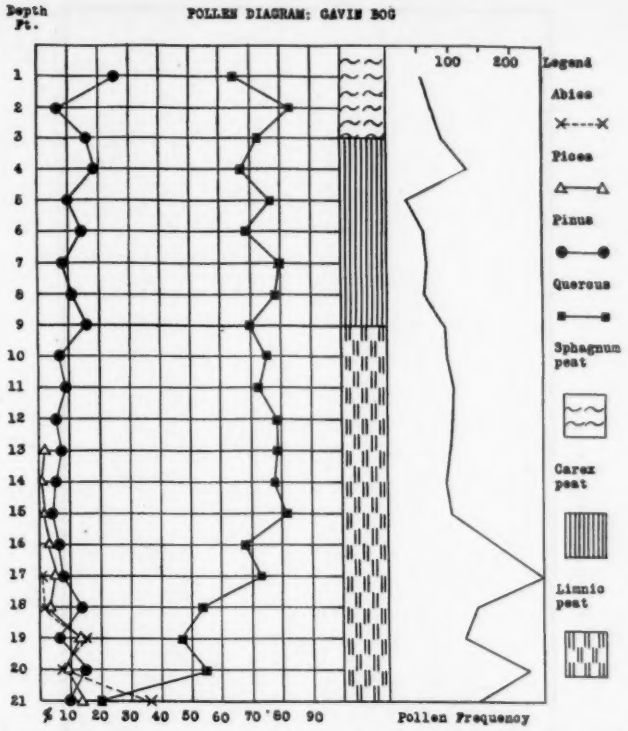

Fig. 2. Pollen diagram of a postglacial bog in Lake County, Illinois. After Voss.

150,000 years ago, and the interglacial period is supposed to have lasted for something like 120,000 years. Recently several peat deposits, known to belong to the Sangamon Interglacial and buried beneath many feet of gravel and loess, have been exposed. Two of these are so thick (135 and 78 inches) that it seems probable that they represent the greater portions of the period. Five of these deposits from Peoria, Bureau, Fulton, Tazewell and Woodford counties, investigated by Voss (21) give a good picture of the climate and vegetation of the period.

The fact that the five records agree so closely adds much to their credibility. The pollen of deciduous trees is conspicuous by its almost entire absence but throughout all the records there is a persistence of fir, spruce and pine with relatively little variation in the proportionate amounts. In one deposit only (the Canton) does oak and hemlock pollen appear. This is the only evidence at present uncovered that there was any marked climatic variation throughout the Sangamon Interglacial although its duration has been estimated at 120,000 years. The persistence of the spruce-fir record indicates a cool climate with a rainfall perhaps comparable to that at present; in other words, a climate similar to that existing today north of Lake Superior. The Canton record suggests that at two intervals there may have been such an amelioration of temperature that some areas of the forest possessed a small proportion of oak, hemlock and associated species. This might mean a climate and a vegetation like that at present existing on the south shore of Lake Superior. These two milder intervals may have occurred before the middle and towards the close of the Sangamon Interglacial Stage and each may have persisted for several thousand years (fig. 6).

The Yarmouth Interglacial Stage is much older than the Sangamon, being

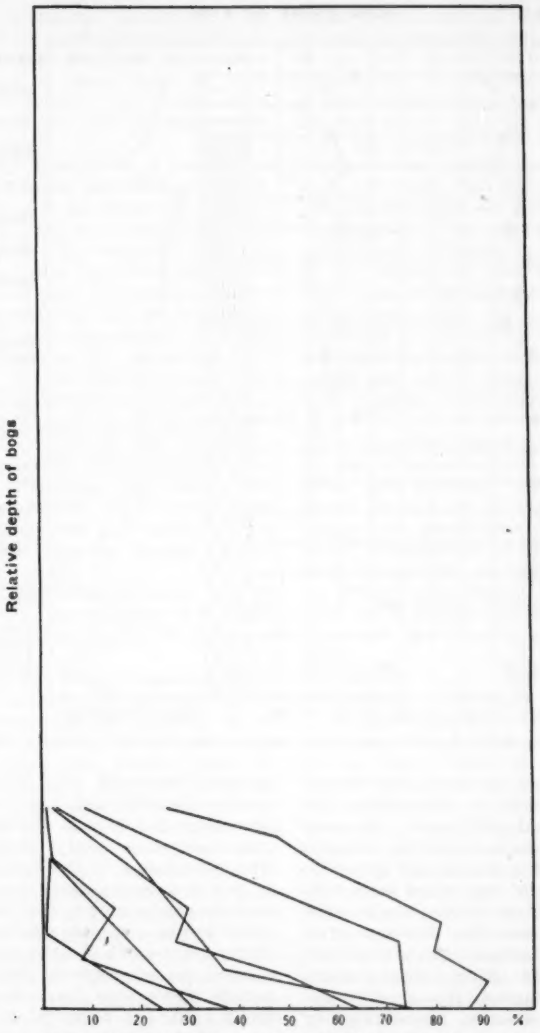

FIG. 3. Graphs showing the occurrence of *Abies* pollen in seven bogs in Lake County, Illinois. The graphs represent depth of bogs vertically and percentages of pollen horizontally. From data by Voss.

separated from it by the Illinoian Glacial that had a duration of perhaps 100,000 years. This would mean that the Yarmouth began over half a million years ago and it seems to have persisted for some 200,000 to 300,000 years. With this prolonged existence it is unlikely that any one peat deposit represents more than a portion of the period. Two deposits of Yarmouth Age found in Adams and Macoupin counties, have recently been studied by Voss (21) partly through the assistance of a grant from this Academy of funds made available by the A. A. A. S.

Of these deposits that at Quincy, Adams County, may be taken as revealing the

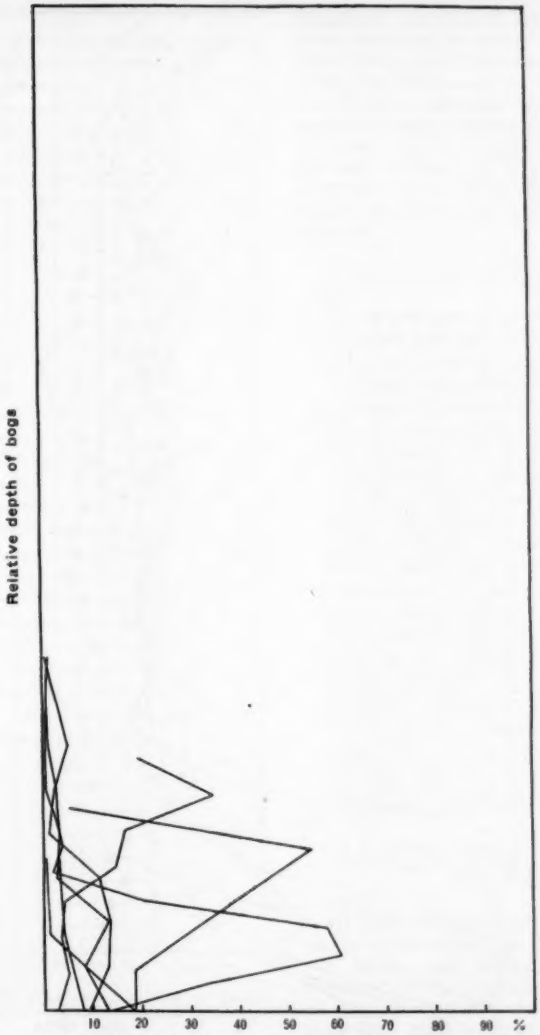

FIG. 4. Graphs showing the occurrence of *Picea* pollen in seven bogs in Lake County, Illinois. The graphs represent depth of bogs vertically and percentages of pollen horizontally. From data by Voss.

forest vegetation of that remote period (fig. 7). The two deposits, however, disclose similar records showing the existence of fir, spruce, tamarack, and pine throughout. In other words, the plant remains indicate the northern conifer forest characteristic of a cool, rather moist climate. This agrees with the conclusions drawn by Baker (1) from his studies of the mollusca of Illinois associated with the Yarmouth period.

INTERPRETATION OF THE RECORDS

In attempting to obtain a more complete picture of the vegetation of Illinois during the past half-million years we

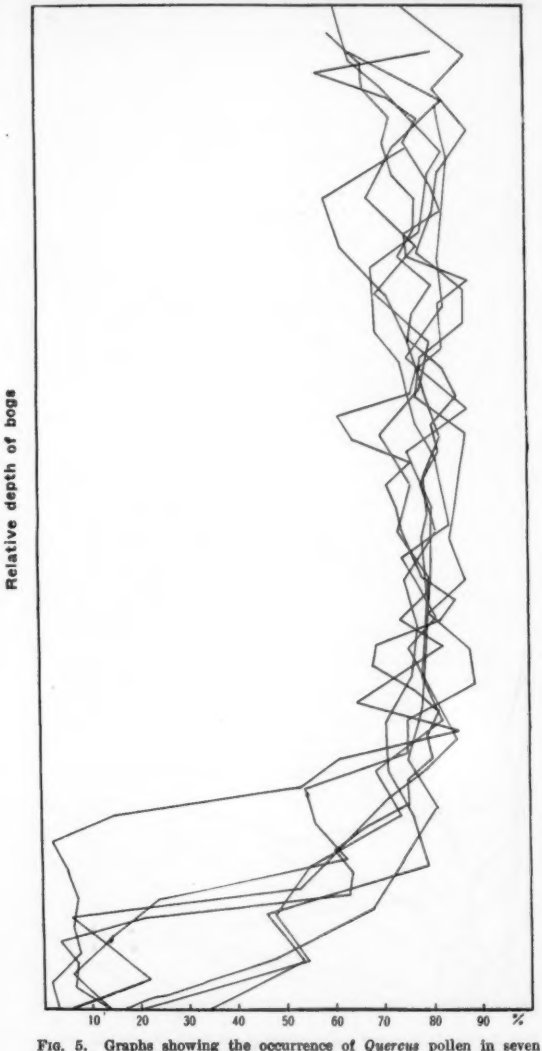

FIG. 5. Graphs showing the occurrence of *Quercus* pollen in seven bogs in Lake County, Illinois. The graphs represent depth of bogs vertically and percentages of pollen horizontally. From data by Voss.

should have as a background the geologic data which have accumulated during the past few decades. These have been brought together in an interesting and relatively non-technical form by Daly (6). They indicate that a climate somewhat cooler than the present obtained for most if not all of Pleistocene time and that precipitation was at least equal to that of the present.

In attempting to translate the bog records into terms of climate and actual vegetation we are faced at the very beginning with the question of whether the forests followed closely upon the margin of the retreating ice sheet or whether a

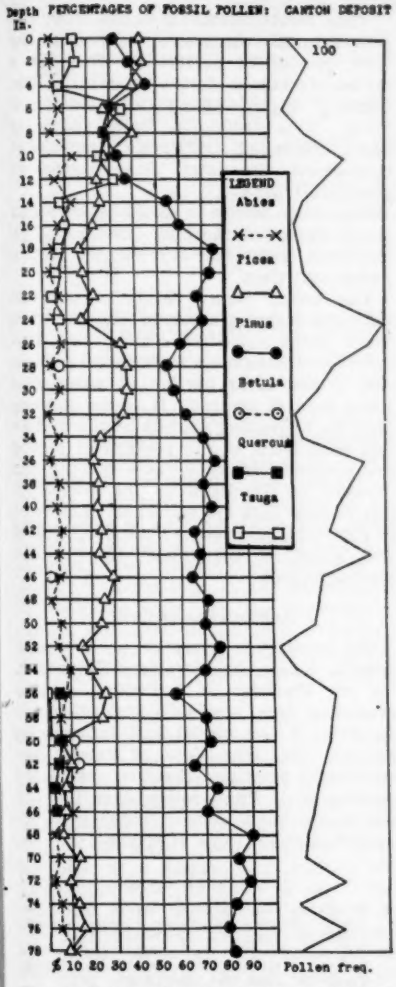

Fig. 6. Pollen diagram of a bog of Sangamon age in Fulton County, Illinois. After Voss.

rather extended period of tundra vegetation intervened. This question is particularly pertinent when applied to postglacial time since Woodard and others have argued in favor of an extended period of tundra vegetation which persisted until invaded by prairie grasses.

Certain facts, however, seem to indicate that there was no wide interval between the ice and the forest. The records of the Early Wisconsin stage and of the Sangamon Interglacial seem to prove that there were conifer forests in north-middle Illinois for many thousand years during which the Wisconsin ice sheet existed in the northern portions of the state. This makes it almost certain that such forests followed closely upon the retreating glaciers. Cooper (5) has recently found a spruce forest following within a few miles the retreating ice front of Alaskan glaciers.

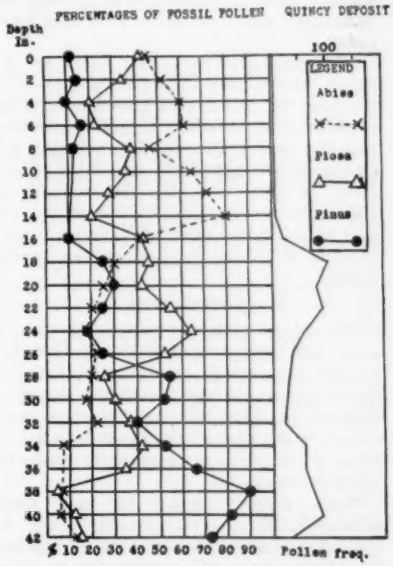

Fig. 7. Pollen diagram of a bog of Yarmouth age in Adams County, Illinois. After Voss.

All these records seem to point to the various substages of the Wisconsin glaciation having been followed closely by a forest of the northern conifer type such as now exists about the shores of Lake Superior. Such a forest must have consisted principally of spruce, balsam fir, species of birch together with some maple. Tamarack, ash and alder also doubtless grew on the swampy areas. This forest seems to have persisted for probably 10,000 to 15,000 years in middle Illinois and perhaps for half that time in the northern portion where the ice sheet had a longer duration.

The greater remoteness in time makes the interpretation of the vegetation of the

Sangamon and Yarmouth periods still more difficult. Recent studies by Braun (3) and by Cain (4), made in parts of the continent not subjected to Pleistocene glaciation, seem to indicate that a flora essentially similar to the present has existed in North America for more than a million years. This means that the same tree genera and probably the same species that now exist in Illinois were present on the continent, and had the same climatic requirements during the Sangamon and Yarmouth, that they have today.

Unfortunately we have little or no direct information as to the relative areas occupied by forest and grassland during those remote periods. The fact, however, that the grassland soils now existing are composed of materials deposited much more recently than the Sangamon and Yarmouth seems to make it highly probable that forests covered a much larger portion of the state than during recent times.

Conclusions

The fossil pollen of Yarmouth, Sangamon and Early Wisconsin interglacial periods supports geological and other evidence that these periods were characterized by cool and moist climates and that during these periods the northern half of Illinois was covered largely with northern conifer forests.

These forests appear to have been similar to those now existing north of Lake Superior, being composed of balsam fir, *Abies balsamea*, spruce, *Picea* spp., pine (*Pinus banksiana* and *Pinus* spp.), tamarack, *Larix laricina*, birch, *Betula* spp., and smaller amounts of associated species. There is at present no evidence that deciduous forests were present during the long Yarmouth period.

Twice during the Sangamon period, there seems to have been a mixture of oaks and hemlocks along with the elements of the more northern conifer forest. These would indicate a somewhat milder climate during some centuries (or thousands of years) in the earlier portion and again towards the end of the period. The data, however, indicate the dominance of northern conifers throughout.

In postglacial times the ice sheet seems to have been rather closely followed by a forest similar to the existing northern conifer forest in which spruce, fir, and pine were notable genera.

This forest seems to have been replaced in Illinois before the end of the first quarter of postglacial time, by a mixed deciduous forest in which oak, hickory, maple, and elm were dominant trees. This deciduous forest seems to have continued, relatively unchanged throughout the later three-fourths of postglacial time.

The pollen record in the Lake Michigan region seems to show no evidence of alternating moist and dry periods during postglacial time.

The pollen record seems to indicate that the forested areas of Illinois were much more extensive during the Yarmouth and Sangamon Interglacial periods and in the early portion of postglacial times than at present. It seems possible that the increasing warmth of the middle and later parts of the postglacial period and greater relative dryness favored the invasion of the forest by the grassland. Our present data are tqo scanty, however, to determine the relative extent of forest and grassland throughout these interglacial periods.

Acknowledgements

The writer is grateful to Professor John R. Ball, of Northwestern University, for his kindness in furnishing certain geological data, especially regarding the duration of the glacial and interglacial periods. Dr. John Voss, of Peoria, has generously permitted the free use of the abundance of fossil pollen data that he has accumulated, some of which were unpublished at the time of writing.

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PLANT GROWTH AND GROWTH HORMONES*

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THE GROWTH behavior of living organisms has received much attention in recent years as the result of important discoveries concerning the control of growth processes. The discovery of the importance of endocrine glandular secretions in the growth and development of animals, the discovery of vitamins as necessary accessories in the nutrition of animals and man, and the discovery of growth hormones in the tissues of plants have all been powerful incentives to the investigation of the processes of development.

Certainly one of the most interesting and amazing characteristics of the living organism is its power of continuous and harmonious development from the simplest beginning to the complex, highly organized and fully grown individual. Most of our higher plants and animals begin life as a single very slightly differentiated cell, the ovum or egg. This egg cell must usually be fertilized by union with another equally simple cell, the sperm. After the fertilization process has been completed, the egg is no longer quiescent, but begins the process of development by a series of cell divisions. As new cells are formed, the body enlarges, and observation shows that the cells begin to arrange themselves after an orderly pattern belonging to the species involved. Cell differentiation occurs, and tissues and organs emerge in an orderly series of events that excites the wonder and admiration of every philosophical biologist. The course of development continues until the organism reaches its full adult size and form, in accordance with its specific inheritance. It is hard to imagine that the towering redwood and the giant Sequoia were once upon a time housed within the confines of a single undifferentiated cell of microscopic size. And it is indeed just as difficult to think of the elephant, or the horse, or of man himself as beginning life with so simple an organization.

When the process of cell division initiates development, one can then observe that every stage of development prepares the way for the next one following. In the case of plant growth, which alone is the concern of this discussion, the unfolding of the organism occurs usually in two cycles of growth. The first cycle of development extends from the fertilization of the egg to the close of the development of the seed. This is the embryonic phase of development, and the cycle ends when the seed dries down and becomes dormant. In this stage it is resistant to conditions of the environment as long as it remains approximately air dry. Even the embryo plant in a seed is a complex being as compared to the fertilized egg. It has a very short root primordium, a short stem, in many instances two leaves stored full of food (the cotyledons), some embryonic leaves at the upper end of the stem, and tissue systems representing the epidermis, cortex, and vascular regions. It is all in miniature form, still far from the complexity of the adult, but vast progress has been made toward the ultimate goal.

Planted in warm moist earth, the

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embryo resumes its activity, enters upon the second cycle of growth, and in orderly succession root system, stems, leaves, flowers and fruit come into being, controlled by the laws of life and heredity, so that each individual faithfully repeats the pattern of its own species. In size, form, and structure, and in the harmony of its development it is recognizable as a member of a definite species, and unlike all other species.

The control of the growth processes of organisms must be affected in part by external forces, and in part by internal factors. We are all familiar with the fact that deficiencies of moisture, necessary elements, light, temperature, etc., modify growth rates and the total growth of the individual. But they act through modification of internal conditions such as the concentration of materials, activity of enzymes, rate of respiration, etc.

The first suggestion that growth responses in plants might be under the control of internal chemical substances was made by Charles Darwin in his book, *The Power of Movement in Plants*, published in 1880. He observed the growth responses of grass coleoptiles to one-sided illumination, and noted that the perceptive and responsive regions of the plant were separated by some distance, and that the stimulus must be transported through the tissues in some manner. The transport of the stimulus was much too rapid for mere diffusion, but Darwin thought there must be some substance which was acted upon by light, and which was capable of rapid transmission of a growth stimulus to the lower part of the leaf sheath.

The term "hormone" was introduced into animal physiology by Bayliss and Starling about 1902, to designate the chemical agents of growth control originating in the endocrine glands. Gradually the use of the term crept over into plant physiology, even before the actual existence of plant growth hormones had been fully demonstrated. The European workers followed in the footsteps of Charles Darwin, and made a great many studies of the responses of the oat coleoptile. In 1910-1911 Boysen Jensen proved the existence of a chemical regulator of growth in the grass coleoptile, but apparently the time was not ripe for the full significance of his work to be appreciated. Many other investigations followed his work, piling up evidence more and more convincing, until in 1928 Went's thorough studies made doubt of the existence of a chemical growth hormone in the oat coleoptile no longer possible. American workers occasionally used the hormone concept to explain growth behavior when they could think of nothing better to suggest. Both growth promoters and growth inhibitors were postulated to explain the behavior of lateral and terminal buds. Appleman's studies of the sprouting of potatoes in 1918 indicated that terminal eyes of the potato inhibited the sprouting of other eyes on the potato, and that the central bud of any given eye suppresses the growth of the lateral buds of the same eye. Removal of the terminal eye, or terminal bud, released the other eyes or buds from restraint.

Jaques Loeb made many interesting studies of Bryophyllum during the last 10 years of his life. Many of the features of geotropic response and regeneration in Bryophyllum were explained on the basis of the distribution of growth substances or hormones. At the time, the idea seemed far-fetched; but at the present time he appears very conservative in comparison with hormone enthusiasts of today. Reed and Halma studied growth in pear trees, and presented telling evidence for the existence of growth inhibitors in the terminal parts of the branches which, flowing down the branches, prevented the lateral buds from developing. Horizontal branches produced sprouts from the upper side of the branch, but sprouts originating on the lower side of the branch grew poorly. The suggested explanation was that the growth inhibiting substance settled into the ventral side of the branch and retarded the growth of sprouts on that part of the stem.

With the discovery of means of detecting growth substances, and of measuring the relative concentration of the hormones by biological assay methods in 1928 (Went), powerful impetus was given to the search for the hormone as a chemical entity. At the time of Went's discovery, no one had the slightest conception as to the nature of the chemical substance responsible for the growth curvatures of oats. Many substances were tested for the presence of growth promoting hormones, and it was soon found that yeast extract, malt extract, and culture media

upon which certain fungi and other microorganisms had grown, contained such substances. In 1931 it was found that human urine was a rich source of growth hormone, and during the period from 1931 to 1935 Kögl and his co-workers obtained enough of the growth substance that they could purify it, and determine its chemical constitution. They found, indeed, not one, but two substances, which have been named auxin a and auxin b. The former is auxentriolic acid, and the latter auxenolonic acid. They are relatively weak acids, and are found widely distributed in living plant tissues.

During the four years since these acids were completely identified and named, hundreds of investigations have been made, and the application of the hormone concept to growth control has been extended to cover many phases of development. Such processes as cell division, cell enlargement, and cell differentiation are made subservient to specific hormones. The growth of the tops of plants is claimed to be controlled by top-forming substances originating in the root; and the root development is said to be controlled by root-forming hormones manufactured in the tops of the plant. Flower buds are initiated by hormones manufactured in the leaves under definite conditions which cause the production or the accumulation of the hormone, which is then carried to the region where buds could arise. The hormone initiates the bud, after which the ordinary nutrients, carbohydrates, amino acids, etc., provide for their growth. The afterripening of seeds during chilling, the breaking of dormancy of twigs in late winter, the production of dwarf forms of corn, the rooting of cuttings, the enlargement of fruits, the healing of wounds, the geotropic and phototropic adjustments of plants, and many other growth phenomena have now been given a "hormone" explanation. One could almost say that the entire growth of the plant, from start to finish, is controlled by a complicated set of chemical factors not nearly all of which are known at the present time.

The current definition of a hormone is so broad that it might include almost any chemical factor. A hormone is a substance which, being produced in one part of the organism, is transported to another part of the organism and there influences a specific physiological process. That definition, however, seems to make most of the transportable substances of the plant body play the part of hormones. Would not a sugar, produced in the leaf, and then transported to the root where it influenced the building of cell walls, fulfill the requirement of the definition of a hormone? Or an amino acid, formed in the root of an apple tree, and then carried to the stem apex where it influenced the formation of new protoplasm; would it not also be a hormone? What I am trying to say is that there does not seem to be so very much difference between hormones and the ordinary nutrient chemicals of the plant body, except that the hormones are present in mere traces.

As time goes on, more and more substances are found which in one situation or another promote growth, or inhibit growth, or initiate differentiation. Besides auxin a and auxin b, such substances as vitamins A, B_1, B_2, and C, biotin, pantothenic acid, nicotinic acid, indole acetic acid, thiazole, pyrimidine, oestrone, etc., have been mentioned as possible plant hormones. The number of these compounds may ultimately be recognized as legion, just as we recognize that the enzymes of the cell are very numerous.

Just what are we moving toward? What interpretation is to be made of this great mass of information which is accumulating as the result of world-wide interest in growth phenomena and hormonal control of development? There seems to be a trend toward a rational point of view which deserves to be emphasized. In some instances plants have been found to undergo growth stimulation when thiazole is supplied, in others when pyrimidine is supplied, and in still others neither alone is active, but vitamin B_1 must be administered. The obvious explanation is that some organisms manufacture their own pyrimidine, and if given thiazole can produce vitamin B_1. Others can make their own supply of thiazole, and if furnished pyrimidine they develop vitamin B_1. Still others make neither pyrimidine nor thiazole in sufficient quantity, and these forms must be given vitamin B_1 already formed, to induce growth.

Similarly, vitamin C is present in some organisms to such an extent that adding more of it produces no additional result in growth. Other organisms do not produce vitamin C readily, and if these are

given vitamin C it provides a growth stimulus. The obvious conclusion is that we are dealing with problems of nutrition on the one hand, and possibly with catalysis on the other.

If hormones become an actual part of the organized structures of the plant body, as may easily be the case with some of them, they are to be thought of as foods in the same sense as carbohydrates and other macronutrients. If hormones speed up chemical reactions, or change the equilibria of chemical reactions within the tissues, their action is no different from that of other organic catalysts, the enzymes.

It seems to me that we are dealing with a situation not different in principle from that which exists with reference to the inorganic elements needed by living organisms. Some of the elements, such as carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, and mangesium are known to build substance in the plant. Others, such as potassium, manganese, iron, copper, zinc, boron, molybdenum, silicon, etc.,* are not certainly structural elements, but they have great significance in the use of material, in respiratory and other catalytically controlled processes. Until recent years it was not known that the trace substances, the micro-elements, as they are often called, are necessary for plant growth. When our chemicals were made pure enough, however, and when our techniques became sufficiently rigid it was not difficult to prove the necessity of the trace elements for life and development.

Now we have come on to the same situation with reference to the organic substances. Formerly we discussed only carbohydrates, fats, and proteins with reference to nutrition. When physiological technique had developed to the point where deficient rations could be prepared, the need of vitamins was discovered. And when the endocrine glands were extirpated, the need of the endocrine hormones became obvious. With the discovery of assay methods, the study of trace organic substances in the nutrition of plants became possible. The substances called hormones today are not a homogeneous group of chemicals. They do not form a class of compounds. They are metabolites of various kinds. Some are nutritive without doubt, others are catalytic, just as in the case of the inorganic elements.

The development of the hormone techniques is giving us the first opportunity we have had to study the influence of trace organic metabolites upon growth and developmental processes. It seems obvious that the amazing perfection of the specific developmental processes which carry any given organism through its life cycle is brought about by the production of specific trace metabolites, chemical inciters, inhibitors, correlators of many different kinds. Each species probably has some unique kinds, or unique combinations of trace chemicals which set the specific pattern of growth. It is not possible at the present time to define these unique specific substances, or unique combinations of them. The work is still too general. The great excursion into this field, however, has thrown brilliant light upon the growth processes of plants, and upon their developmental behavior. A sound foundation is being built for other and far-reaching advances which may ultimately provide controls for plant growth which man can operate at will. If we know under what conditions certain trace metabolites are formed, and what responses the plant makes in growth and development when these trace metabolites are present in sufficient concentration, we are only a step away from the complete control of the organism's development. We are moving steadily forward toward this goal, with all indications that practical control will be achieved in the not distant future.

STATE FORESTRY IN ILLINOIS*

ANTON J. TOMASEK

State Forester, Springfield, Illinois

I WOULD LIKE to take this opportunity to familiarize you with some of the activities and objectives of the State Forestry Division and tell you what has been accomplished and what we propose to accomplish in this important branch of the State government.

The State Division of Forestry was organized in 1926 as a division of the Department of Conservation. It was organized as a result of an increased need for proper forestry practices within the State on the part of the owners of timber land. The organization of the Division was also brought about by interested individuals who analyzed the forestry problems of the State and deemed it imperative that something be done to restore our natural forest areas.

The Division of Forestry operates on funds received from a general appropriation granted by the State Legislature every two years. For eleven years appropriations for this important field of activity had been comparatively small. The average expenditure, per biennium, during this period was approximately $55,000. At the request of Governor Henry Horner and Director of Conservation Thomas J. Lynch, the last Legislature increased the biennial appropriation for forestry for the period July 1, 1937 to June 30, 1939 to $171,000. This increase was warmly welcomed by all lovers of conservation and forestry in the State and has enabled us to inaugurate a well-balanced state forestry program.

The objectives of the Division of Forestry are: first, to promote and assist in the reforestation of idle lands unfit for agriculture; second, to prevent forest fires, not only on State owned land but on private forest lands throughout the State where a sufficient amount of timber is present to warrant expenditures; third, to control erosion by the planting of trees; fourth, to establish State forests to act as demonstration areas in proper timber land management; fifth, to give assistance to Illinois land owners and corporations in their forestry problems; sixth, to disseminate forestry knowledge through the publication of forestry literature.

Of these objectives, the most important work of the Division is to promote and assist in the reforestation of idle lands now unfit for agricultural purposes. We have in Illinois today approximately 3,000,000 acres of such lands which are not being tilled and are not producing any timber crop. In their present state, therefore, their value is nothing. All this vast acreage is entirely in the hands of private land owners. There is no way in which the Division of Forestry can compel such land owners to reforest their lands or put them to some beneficial use. Our approach to this problem is through education, by demonstrating that such lands unfit for agriculture should be producing timber for profit.

The State Division of Forestry is doing everything possible to assist all land owners who are willing to reforest their idle lands. Two State nurseries have been established during the past four years for the production of forest and erosion control planting stock. The largest of these nurseries, the Horner Tree Nursery near Havana, can produce ten million trees annually for such plantings. The second nursery, the Thompson Tree Nursery located at Jonesboro in the extreme southern part of the State and named for the late Director of Conservation, Charles F. Thompson, has a capacity of five million trees annually. Both nurseries have been developed recently to a highly efficient stage, making it possible to produce fifteen millions of trees annually at nominal cost.

Tree seedlings produced at State nurseries are sold to farmers and land owners almost at cost for the reforestation of any lands unfit for agriculture. The following restrictions are placed on trees purchased from the State:

1. Trees are to be planted for the establishment of a new forest, or for the improvement of a forest already existing, and are not to be used for ornamental or landscaping purposes.

* Address presented before the Thirty-second Annual Meeting of the Illinois State Academy of Science, Springfield, Illinois, May 5, 1939.

2. Trees must not be dug, cut off, or otherwise moved and resold, until they are large enough to be sold or utilized as merchantable timber.

3. The planted area must be protected from forest fires, trespass and grazing by domestic livestock.

4. For the purpose of inspecting the planted area, the Division of Forestry, or its agents, will be given unrestricted access to the property on which these trees are planted.

Every effort is made by the Division to prohibit its trees being used for ornamental or landscaping purposes. It is not the intention of the Division of Forestry to sell trees for ornamental purposes in competition with commercial tree nurserymen who have excellent stock suitable for this purpose. Trees produced at State nurseries are produced solely for the purpose of providing planting stock for future forests. In view of this fact trees are sold only in lots of 500 or more.

Interest in reforestation has undoubtedly increased greatly in the last three years. In 1936, 176,000 trees were distributed for forest plantings, in 1937, 655,000, in 1938, 3,740,000 and this spring 4,829,000 were distributed from State nurseries. It can readily be seen, therefore, that the program of planting for future forests in Illinois is rapidly taking hold.

A new program in forest plantings was started by the Forestry Division in cooperation with owners of worked-out strip mine areas in the State during the past year. Undoubtedly many of you have seen the large spoil banks left by strip coal operations. It was deemed feasible by the Division of Forestry that such lands could well be reforested and be put to a profitable use by the production of timber. Conferences were held with the Illinois Coal Strippers Association who were enthusiastic about such a program and the Division of Forestry agreed to make surveys of such areas and provide the owner of strip mine lands with definite recommendations as to future forest plantings on such areas. The surveys were made and eight companies cooperated in actual planting operations during the spring of 1938 and planted 300,000 trees which were purchased from the Division nurseries. The strip mine owners furnished all necessary labor and the work was done under the supervision of a trained forester of the Forestry Division. Planting inspections during the summer of 1938 have proven that this new venture was highly successful since approximately ninety-five percent survival of trees has been obtained. Strip mine companies continued this program with the Division this spring and 1,000,000 trees were planted, the last of the plantings being completed two weeks ago.

Benefits as a result of revenue derived from a timber crop are not all that can be expected of these plantations. In addition, such tracts will provide ideal recreational areas for the public in the future and will provide excellent wild life areas.

Planting trees for future forests in Illinois must necessarily be taken seriously by all owners of lands unfit for agriculture as a definite business proposition and timber should be considered by such individuals as a long term crop. At present, Illinois is a heavy consumer of wood products and pays from twenty-five to thirty million dollars a year on freight on timber shipped into the State. Lands in the State suitable only for the raising of trees, if producing timber at full capacity, would be of material help in reducing this freight bill, thereby effecting a cheaper price in lumber to the consumers in Illinois, and, at the same time, a fine return would be obtained for the owners of forest lands. Taxes are being adjusted in some states on timber land so that every encouragement is given to the owner to plant and maintain his forest area. The greatest problem confronting us today is the fact that many neglect to plant for future forests due to the fact that taxes must be paid over a long period of years during which time there is no return as there is when the owner plants an annual crop. The only remedy to this condition is by passage of tax exemption acts providing for a very nominal tax on forest lands. Such an act, if passed by our State Legislature, probably would be unconstitutional, therefore, it is necessary that at some time in the future our constitution be amended to provide for the tax exemption of forest lands as is being done in many states today.

Serious erosion of soil is going on in many parts of the State, especially in the south. This is taking place particularly on steep hill slopes which have been denuded of timber and which have been improperly farmed in the past. Trees

planted on such land, especially the Black Locust, which has a very fibrous root system, are ideal for controlling erosion. In planting this tree for erosion control, it has a three-fold purpose: first, its fibrous root system holds the soil and prevents further erosion; second, in view of the fact that the roots are of a nitrogenous nature it will improve the soil fertility and, third, the Black Locust will produce a crop in view of the fact that Black Locust trees will attain fence post size in from ten to fifteen years and they are ideal for that purpose.

Trees planted on hillsides also serve another very important purpose, that being watershed protection. Undoubtedly the cause of our major floods in the country in recent years has been due to the fact that many of the watersheds have been stripped of their forests, resulting in a rapid runoff to the main streams and rivers. Where such watersheds are well-forested, the falling leaves and litter form a blanket over the forest floor which keeps the soil moist and porous and virtually acts as a sponge, holding the water and releasing it slowly. Illinois has been affected by floods many times in recent years and the reforestation of watersheds, not only in this State but in our neighboring states, is of vital necessity to prevent such reoccurrences.

We have in Illinois today approximately four million acres of timbered lands. The original timber stand in Illinois was approximately fourteen million acres or about forty-five percent of the total land area of the State. The major part of the four million acres remaining is located in the southern portion of our State. Practically the entire forest acreage is confined to farm woodlands with the exception of approximately 160,000 acres of land which comprise the Illini and Shawnee purchase units of the U. S. Forest Service in the southern part of the State, 3,400 acres of land which comprise the Union County State Forest and 5,000 acres of land recently purchased by the Division of Forestry as a State Forest in Mason county. Of the four million acres of timberland remaining in the State, approximately two million acres should be given protection from forest fires which is the greatest enemy of a forest area. Until 1937 no forest fire protection was afforded private forest lands in the State. As a result of the increased appropriation granted the State Division of Forestry, we have been enable to inaugurate a program in forest fire protection and at the present time approximately 350,000 acres are under intensive forest fire protection. Our increase in appropriation has enabled us to construct fire towers, purchase forest fire fighting equipment, trucks, and hire forest fire wardens to carry out this phase of our forestry program. In addition to this we have just completed our main forest fire protection headquarters near Benton, Illinois at a cost of $14,000.

Fire in the city is something that can readily be transferred to a visible dollar and cents problem. The damage is plainly seen. The damage done by forest fires can only be appreciated by those who know timber and timber values. There is also a definite loss in dollars and cents but it takes an expert to see it. Every time a fire occurs some of the top layer of soil is destroyed thereby decreasing the fertility of the area. Fires also scar the base of trees, not only causing a loss in lumber when the tree is cut, but provides an entry for disease and insects. Forest fires destroy the habitat for game, its food and, in many cases, the game itself. In addition to this, many indirect losses can be recorded. Forest fires are caused almost entirely by negligence on the part of the public. Smoking in the woods and throwing away a lighted cigarette or match is undoubtedly the most usual cause.

The cooperation of the public is requested in this vital program of forest fire protection. Although the danger is most serious in the southern part of our State, it is also serious in areas such as the Cook County Forest Preserve District which has approximately 35,000 acres of timbered lands, and other timbered sections of our state.

One of the objectives of the Division of Forestry is to establish a number of State forests to provide demonstration areas in proper forest management. Illinois at the present time has two State forests. One of the two, the Union County State Forest located in the southern part of the State, comprises 3,400 acres. Through the efforts of the Civilian Conservation Corps and the Works Progress Administration under the supervision of the State, proper forestry practices on this tract have been inaugurated and, in

addition, the area has been developed as an excellent recreational tract for residents of southern Illinois.

Through the efforts of Governor Horner the last State Legislature granted $50,000 for an additional State forest to be purchased in the western part of the State during the present biennium. This has recently been acquired and development work has been started. It is hoped that our program will enable us to have some day a number of State forests located in every section of the State in order that farmers and land owners may be able to visit near their homes, a properly managed forest and a forest area which can bring a profit to its owner. We feel that if the State will point the way by such demonstrational areas, cooperation on the part of the forest land owner can more easily be obtained.

In many of the eastern states, many communities are purchasing potential forest lands and practicing proper forest management, setting these areas aside as community forests. Every effort is being made by the Division of Forestry to interest cities and villages to inaugurate a similar community forest program. Such a forest program is especially fitting where cities or towns own lands surrounding a lake which is their reservoir and drinking supply. It is important that the watersheds of these reservoirs be planted with forest trees to prevent silting. We have sixty-one such reservoirs in Illinois at the present time and under the direction of the Division of Forestry, surveys are being made of them and submitted to the town or city officials with the hope that such areas will be planted, thereby providing a community forest for the people of those cities.

Of the hundred and two counties in Illinois, six counties have forest preserve districts maintained as natural recreational areas. Those counties and the acreage they have at present are as follows:

County	*Acres*
Cook	35,000
DuPage	1,010
Kane	350
Will	613
Winnebago	1,116
Piatt	108

The Cook County Forest Preserve District of 35,000 acres, under the able direction of Charles G. Sauers, general superintendent, serves millions of people annually and illustrates, without a doubt, the value of a forest area to the citizens of a community.

The dissemination of forestry literature by the Division of Forestry, in an attempt to increase interest in forestry, has greatly assisted in furthering our program. Publications issued free of charge at the present time are as follows: "Forest Trees of Illinois and How to Know Them" is a 76-page booklet describing the native trees of the State and explaining as simply as possible how to identify them. Approximately 25,000 copies of this publication are distributed annually to school children and adults. "Elements of Forestry," a 30-page booklet provides general forestry information especially as it pertains to Illinois. Miscellaneous publications on tree planting are also issued.

I have tried briefly to summarize the Department of Conservation, Division of Forestry's duties and activities.

In closing I wish to state that the Division is always happy to receive inquiries on our State forestry program and to assist individuals with any forestry problems that they may have.

SOME NEW EXHIBITS AND UNDERTAKINGS OF THE ILLINOIS STATE MUSEUM*

THORNE DEUEL

Chief, Illinois State Museum, Springfield, Illinois

ON BEHALF of the Illinois State Museum and its staff, I cordially welcome the members and friends of the Illinois State Academy to Springfield and to the Museum. My only regret is that the Museum does not have the facilities to provide its own auditorium and rooms for the use of the Academy and its sections.

I shall touch very briefly on the aims of the Illinois State Museum, by saying that our goal is to develop the exhibits to interest and entertain the average citizen—the non-specialist rather than the scientist—without sacrificing scientific accuracy and to show the life, life forms, culture and industry of Illinois from earliest times to the present against the background of the corresponding environments existing in the region at these periods. It shall further be the task of the Museum to indicate to the people of the State by suitable exhibits the resources and industries of Illinois and the achievements and work of the State Departments and by suitable booklets and pamphlets on these topics to advertise the State both to its own citizens, to those of the other United States and to foreign countries.

Our goal today is to see that all members of the Academy who can conveniently do so, visit the Museum on the fifth floor of the Centennial Building.

Even though we can't provide you with space for your meetings, we would like to entertain you by showing you some of our more recent undertakings and acquisitions of the museum. With this in mind, I urge that no one present at any meeting of the Illinois State Academy go home without seeing four of our new projects and exhibits which I shall mention and describe briefly: (1) the new Oriental Room in the Art Gallery, (2) the Diorama Series, (3) the Langford Fossil Loan Collection, (4) the Herbarium.

The Herbarium is in the Board Room and the Secretary will be glad to show you the new cases and the mounts in transparent envelopes. This now has

Fig. 1. Diorama: A new tool.

* Address presented before the Thirty-second Annual Meeting of the Illinois State Academy of Science, Springfield, Illinois, May 5, 1939.

Fig. 3. Chinese Ancestral Portrait.

Loaned to the Illinois State Museum by Major Thomas Dresser White, United States Army.

Fig. 2. Diorama: Merchant Venturers in Bronze.

about a thousand specimens from the Dr. Vasey collection made between 1845 and 1860, as well as 250 specimens recently collected and mounted by Dr. George D. Fuller of this Academy.

The Langford fossils were collected, selected and developed by George Langford, Sr., and George Langford, Jr., of Joliet, from 225 to 250,000 nodules from the strip mines south of Wilmington, Illinois. In the course of the next month a popular publication describing these fossils, "Leaves and Stems from Fossil Forests", by Raymond E. Janssen will be issued by the Illinois State Museum and will be available to the public at a small cost. This collection, now exhibited in the central aisle of the main hall, will probably eventually become the property of the State.

Of the dioramas, seven of the fifteen scenes projected for the cultural series are completed. These show some of the inventions and discoveries in man's progress underlying modern civilization in Illinois. (See figs. 1 and 2.)

The new Oriental Room in the Art Gallery is just begun. Recently Major Thomas D. White, Air Service, U. S. Army, loaned to the Museum 62 Chinese ancestral paintings which formerly hung in family temples. See fig. 3 for one of these. The Misses Helen and Eliza Condell donated to the Museum an embroidered wall hanging from Canton. Some of these acquisitions have been hung temporarily to give some idea of how the Oriental Room will look when completed. Lighting will eventually all be indirect, the floor covered with inlaid linoleum medallion insets, 3½ feet in diameter, of Persian design. The pilasters will carry painted designs when finished.

For the convenience of Academy members, the Museum will be kept open from five until half after six and guides will be present to show these exhibits. Immediately after the evening meeting the museum will be open until 9:55 for the benefit of those who have been unable to see it earlier. I hope all who can will come again after the evening meeting.

MEMOIRS

SIMEON E. BOOMER
1875-1938

SIMEON E. BOOMER, for 25 years head of the Physics and Astronomy Department at Southern Illinois State Normal University, Carbondale, Illinois, died January 3, 1938, at the age of 63, after a lingering illness of 14 months. Mr. Boomer had been associated with the University for 27 years, coming as head of the Mathematics Department in 1911 and transferring to the Department of Physics and Astronomy in 1913.

Mr. Boomer had a wide range of teaching experience, having taught two years in rural schools, eight years in high school and two years in the University of Illinois Academy before joining the faculty of S. I. S. N. U. As a boy he entered the preparatory school of S. I. S. N. U. and here continued his education until he graduated. Later he received A. B. and A. M. Degrees from the University of Illinois. He was a member of the Illinois State Teachers Association, holding a number of offices in that organization, and also a member of the Illinois State Academy of Science. During his entire residence in Carbondale he belonged to the Presbyterian church and much of the time was very active in its affairs.

Emphasis should be placed on his love of astronomy. Often he expressed profound respect for the inspiring beauty and magnitude of the limitless, mysterious, and unexplored spaces of the universe. His astronomy students will remember the regard for the Creator which he led them to deduce from their study of the sky.

He was a familiar figure in Southern Illinois and will long be remembered by the thousands of students who sat in his classes.

OTIS B. YOUNG.

CATHERINE A. MITCHELL

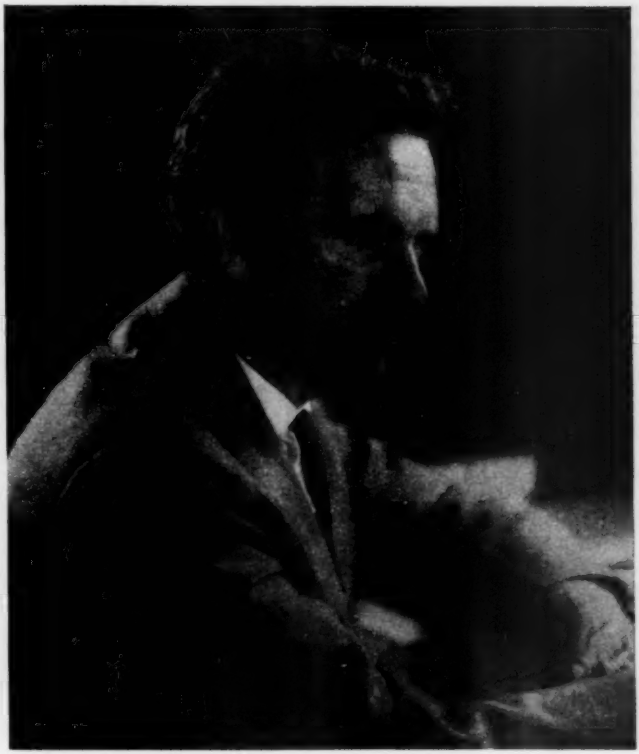
"WITH MALICE toward none and charity for all" was genuinely a guiding motive in the life of Catherine A. Mitchell, who on August 23, 1938, surrendered her earthly life to the life beyond. Known for her loyalty and her kindliness, she was held in esteem and her friendship cherished by all who knew her. The supreme pleasure of her life was not the hilarity of the passing show, but being of service to someone in want or distress. She thus won the profound respect of her friends and acquaintances.

Miss Mitchell was an active member of the Illinois State Academy of Science and of many clubs of nature lovers. She held office in some, and with intense devotion did her share to help preserve for posterity our wild life and our trees and woods. She was never found wanting in her zeal to give the denizens of the fields and forests, and the forests themselves, a chance to live and flourish unmolested. Her deep-seated religion was conservation in the fullest sense of the word, and her love of the out-of-doors was the crowning glory of her life.

She will be missed by the Illinois Audubon Society, of which she was secretary for many years. She held a similar office in the Conservation Council; the Friends of our Native Landscape have a vacant chair in the Board of Directors; the Prairie Club and the Wild Flower Preservation Society have lost one who labored wholeheartedly in their support. Conservationists and naturalists of the entire Chicago area will for years to come have cause to remember the work of Catherine A. Mitchell.

E. T. BARODY.

JAKOB KUNZ
1874-1938



IN THE PASSING of Professor Jakob Kunz the University of Illinois has lost one of its distinguished faculty members. His death brings sadness to his colleagues and to hundreds of students who knew him as a teacher.

He came to the University when a comparatively young man and became an influential member of the faculty during his twenty-nine years of service. As a teacher, he won the respect of his students with his thorough knowledge of the subjects he taught and his effective presentation of the material. In his scientific investigations, he was aggressive and industrious, so that he soon became well-known as a leader in the domains in which he was interested.

Professor Kunz was born in 1874 in Switzerland and obtained his education there, completing it with the degree of Doctor of Philosophy from the University of Zürich in 1902. He served as a chemist in the Gesellschaft für Chemische Industrie in Basle, Switzerland, 1897-1900; as an instructor and privat-docent in physics in the Zürich Polytechnicum, 1900-1907. He then spent a year in England at the University of Cambridge studying with Sir J. J. Thomson. In 1908 he came to the United States as an instructor in physics at the University of Michigan. The following year he joined the University of Illinois faculty and served as a member of that body until his death. He was a member of the American Physical Society, American Optical Society, American Astronomical

Society, American Association for the Advancement of Science, Sigma Xi, and Phi Beta Kappa. He was also active in the Illinois Academy of Science.

Dr. Knuz's scientific activities were wide and varied. He was known as an outstanding mathematical physicist, but he also engaged in many experimental problems. In 1907 he wrote a book entitled "Theoretische Physik auf Mechanischer Grundlage." He had planned this past summer to complete a second book on theoretical physics which would set forth his applications of analytical functions to the solution of physical problems. Among his experimental projects might be mentioned his work in magnetism, about which he wrote a comprehensive bulletin for the National Research Council; his participation in three solar eclipse expeditions in company with astronomer Professor Joel Stebbins; and his widely-known experiments with the photoelectric cell, a device that has been used extensively in scientific investigations and in engineering applications. Dr. Kunz published numerous papers on his theoretical and experimental investigations, both in this country and abroad.

No estimate of Dr. Kunz would be complete without a consideration of his personality. He had great personal charm, and he was always pleased to meet people and genuinely interested in their affairs. Another outstanding characteristic of Dr. Kunz was his honesty. In all matters, both scientific and otherwise, black was black, and white was white with him, and he was always fearless in expressing his convictions. This honesty of purpose and his stubborn defense of what he thought was right led him into many animated discussions. Dr. Kunz was deeply religious, and he often found occasion to discuss with students and faculty members his beliefs about the relations between science, philosophy, and religion.

We have lost in Dr. Kunz not only an eminent scientist and an inspiring teacher but a man we respect; who based his actions on his ideals with little regard for his material welfare. His example will continue with us as an inspiration.

F. R. WATSON.

HERBERT W. MUMFORD
1871-1938

IN THE DEATH of Herbert Windsor Mumford, the entire field of science as well as the farm people of Illinois and his staff of members and co-workers have lost a sincere friend and a wise counselor. He was for many years a member of the Illinois State Academy of Science and of the American Association for the Advancement of Science.

As Dean of the College of Agriculture, Director of the Agricultural Experiment Station and Director of the Extension Service, he sought not personal credit but accomplishment. He had a broad and well-defined conception of the functions of the University and sought their fulfillment zealously.

His interest in the students of the College never lessened no matter how other responsibilities increased. When it became necessary for him to delegate much of the detail work with students, he continued to see them whenever they came to his office even though other conferences had to be interrupted. Had he been free to follow his own desires, he would have spent much more time with students.

The guidance he gave to the men and women of his staff, not only directly but through his unusual gift for planting fertile suggestions in the minds of others, was one of Dean Mumford's greatest contributions. Sympathetic and patient, he was deeply interested in the problems and personal achievements of his staff

and in their advancement; and he was anxious to give full credit for good work. Always sincere, and with ingrained and highly developed critical faculties, his view of a situation and his advice were frequently valued even more in retrospect than at the time. A vein of homely humor revealed his underlying friendliness and human understanding. Quietly courageous, he never hesitated to give his honest opinion nor to suggest changes in procedure when convinced that the welfare of the institution or of individuals called for change. For these qualities he was widely recognized, respected, and esteemed.

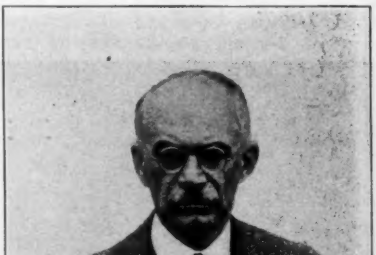
A faithful champion of the man on the farm, Dean Mumford exerted a powerful influence in his behalf, especially when situations arose where the interests of other groups were opposed to those of farm people. He sought earnestly to direct the activities of the Experiment Station and the Extension Service toward the solution of the most important problems of Illinois agriculture.

Striving always for improvement in the discharge of his own responsibilities, he constantly urged the staff to reexamine the research and extension programs of the institution in an effort to make them more effective. He encouraged the teaching staff to secure the best training possible both in subject matter and in teaching methods.

His success as a director of research and an administrator was heightened by the fact that he, himself, was a scientist of rare ability. This was manifest not only in the pioneering investigations which he conceived and carried through in the fields of animal husbandry production and marketing, but also by the scope of the research program which he inspired and fostered among staff members of the Experiment Station.

Thoroughly trained, and endowed with rare native ability, he traveled extensively in the United States, Mexico, Canada, the Argentine, and Europe, developing breadth of understanding and foresight possessed by few. These characteristics contributed to the conception of proper public relations for which he was widely recognized by leaders in the State, by his associates in the Association of Land-Grant Colleges and Universities, and by officers of the Federal government.

ADOLF CARL NOÉ
1873-1939



AFTER THIRTY-SIX YEARS of varied services to the University of Chicago, Adolf Carl Noé died quietly in his sleep early on the morning of April 10, 1939. Dr. Noé who had been in charge of the field of paleobotany for sixteen years, was to have retired on October 1, and he was particularly anxious to put his scientific "affairs in order." Saturday, March 11, therefore, found him at his office busy working on the final chapter of what will doubtless be his most important scientific memorial —the Stutzer-Noé Textbook on Coal. There, in the midst of his labors, he suffered the paralytic stroke from which he was unable to rally.

Dr. Noé was born in Gratz, Austria, on October 28, 1873, the son of Adolf Gustav and Marie (Krauss) von Noé. He attended the University of Gratz from 1894 to 1897, and the University of Göttingen from 1897 to 1899, during which year he came to the United States. Entering the University of Chicago he received the A.B. degree in 1900, and the Ph.D. in Germanic languages, in 1905. Although he was originally interested in the sciences, and had been a "demonstrator" in paleobotany at Gartz, he found it easier in this country to obtain employment teaching languages. After a year of such work at Burlington, Iowa, where, on July 3, 1901, he married Mary Evelyn

Cullatin, Dr. Noé became instructor in German at Stanford University. Returning to Chicago he was instructor and assistant professor of German literature (as well as an assistant librarian) from 1903 to 1923. At this latter date he found it possible finally to return to his field of original interest, and he became assistant professor of paleobotany. The following year he was promoted to an associate professorship and made curator of fossil plants at Walker Museum.

Even before Dr. Noé succeeded in making a place for his subject in the curriculum at Chicago, he had in 1921 become geologist on the staff of the Illinois Geological Survey. This position he occupied until his death, his last active field season having been that of 1938. In addition, he had served in a similar capacity on the State surveys of Kentucky and Iowa. In 1927 he was geologist for the Allan and Garcia Coal Commission to Soviet Russia and did considerable pioneering work, especially in the Donetz coal basin.

In addition to the Stutzer-Noé Text now in press, Dr. Noé was the author of "The Fossil Flora of Northern Illinois," "The Golden Days of Soviet Russia" and "Ferns, Fossils and Fuels," as well as a number of shorter contributions. The now prominent study of "coal balls" was fathered in North America by Dr. Noé, and he and his students did much to bring it to its present position of importance. He was also an able technician, a student working under his direction having perfected the nitro-cellulose peel method for studying sections which now has such wide usage both here and abroad.

During his many summers devoted to the study of the Coal Measures of Illinois for the Illinois State Geological Survey, he made a large paleobotanical collection for the State Survey and for the Walker Museum, and in addition he obtained for Walker Museum, through the auspices of other state surveys and by his own efforts, other large collections from other areas and from formations of several different ages.

Since he had the ability to attract students of real promise, he leaves an active group of younger scientists who will be able to do what doubtless he himself might well have done had it not been for the quarter century Germanic literature hiatus in his scientific career.

His worth was well appreciated in many quarters. He received the Sc.D. from Innsbruck in 1922 and, in 1923, the honorary Ph.D. from Gratz, as well as the gold medal of the University of Vienna. He was a member of the Société Géologique de France, the Geological Society of Mexico, and a fellow of the Geological Society of America as well as of the American Association for the Advancement of Science. He was vice-president of the Paleontological Society in 1931, and the same year held similar office in the Illinois Academy of Science. In 1927 he was chairman of the Chicago Section of the American Institute of Mining and Metallurgical Engineers, and in 1937, he was chairman of the Paleobotanical Section of the Botanical Society of America. In 1934 he became a research associate of the Field Museum and was responsible for the technical direction in the preparation of the museum's great reconstruction of a Carboniferous forest.

Dr. Noé engaged in many extra-curricular activities. He was an enthusiastic horseman, a redoubtable fencer and an expert marksman. For many years he coached the Chicago fencing team and was the instructor of the Rifle Club which he helped to organize. In 1921 Dr. Noé served as treasurer of the American Commission for Vienna Relief so successfully that the grateful nation bestowed upon him the Officers Cross of the Order of the Austrian Republic. Tall and distinguished, of noble birth, Dr. Noé was, in his joviality and innate kindness, kin to all mankind. He was as much at home with a simple coal miner as at the banquet tables of the great and near great. His fame as a raconteur was widespread, and his lectures commonly illustrated with colored slides of his own manufacture, were in constant demand. That such a lovable character out of the "old school" will be keenly missed and kindly remembered, in many circles in addition to the scientific, is a poor understatement. His good friends were legion. They ranged from eight to eighty, from the impoverished to the affluent, from the uneducated to intellectuals.

Dr. Noé is survived by his wife and his daughters, Valerie Noé and Mary Helen Noé, wife of Professor Robert S. Mulliken, of the department of physics, University of Chicago.

CAREY CRONEIS.